NON-PUBLIC?: N
ACCESSION #: 9210200331
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Trojan Nuclear Plant PAGE: 1 OF 7

DOCKET NUMBER: 05000344

TITLE: Reactor Trip Caused by the Failure of the Controller on Main Feedwater Pump 'B' Due to Electronic Component Failures
EVENT DATE: 07/22/92 LER #: 92-020-01 REPORT DATE: 10/15/92

OTHER FACILITIES INVOLVED: N/A DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: D. L. Claridge, Compliance TELEPHONE: (503) 556-5541
Engineer

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: JB COMPONENT: TC MANUFACTURER: W120
X BA 65 W290
D JB 65 W290

REPORTABLE NPRDS: YES
YES
YES

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On July 22, 1992, the Trojan Nuclear Plant experienced a reactor trip from 100 percent power. The trip was caused by the loss of flow from the 'B' Main Feedwater Pump (MFP). At the time of the trip, both MFPs were in manual control due to oscillations in automatic flow control. Following the reactor trip, the 'A' Auxiliary Feedwater Pump (AFW Pump) started, but tripped on overspeed shortly after starting. Subsequent attempts to start the 'A' AFW Pump failed. The failure of the 'B' MFP was due to an electronic component failure on its governor's electronic control assembly (Woodward Model 8270). The control problems with the

'A' MFP were caused by a failed electronic component on its flow controller (Westinghouse-Hagan Model 124). The 'A' AFW Pump failure was caused by a failed integrated circuit on the Ramp Generator Signal Converter in the Woodward Governor turbine startup control circuitry. Corrective Actions included repairing and/or replacing the failed components and circuit boards. There were no safety consequences resulting from the component failures. The 'B' AFW Pump functioned as required to provide cooling water to the steam generators. Other plant systems functioned as expected.

END OF ABSTRACT

DESCRIPTION OF EVENT

On July 22, 1992, the Trojan Nuclear Plant was in Operational Mode 1 (Power Operation) at 100 percent power. At 0126 hours a reactor trip occurred on low-low steam generator level due to a loss of feedwater flow from the 'B' Main Feedwater Pump (MFP) SJ, P!.

Both 'A' and 'B' MFPs were in manual at the time of the reactor trip. Manual control had been established on the 'A' MFP on July 6, 1992 due to oscillations in the controller while in automatic flow control. On July 20, 1992, the 'B' MFP was placed in Manual when operating personnel were unable to maintain stable feedwater flows while in automatic. On July 22, 1992, while in manual and with no operator action, the 'B' MFP slowed to its minimum speed and flow. Manual attempts to increase pump speed were unsuccessful, and the Control Operator tripped the 'B' MFP, which initiated a turbine runback. Approximately one minute later, the reactor tripped on low-low steam generator level.

Immediately after the reactor trip, the Turbine-driven Auxiliary Feedwater Pump (the 'A' AFW Pump) (BA, P) Auto-started. A few seconds later, the 'A' AFW Pump tripped on overspeed. Two subsequent attempts to restart the 'A' AFW Pump also resulted in overspeed trips. The Diesel-Driven Auxiliary Feedwater Pump (the 'B' AFW Pump) (BA, P) operated properly to supply cooling water to the steam generators during the transient.

The reactor trip was a Reactor Protection System (RPS) JE! actuation, and the initiation of Auxiliary Feedwater was an Engineered Safety Features (ESF) JE! actuation. Both events were reported under 10 CFR 50.72 (b) (2) (ii) on July 22, 1992 at 0330 hours, using the Emergency Notification System. This report is being submitted to fulfill the requirements of 10 CFR 50.73 (a) (2) (iv).

Sequence of Events

July 6, 1992 Control Operator (CO) received 'Lube Oil Pressure
2350 hours Lo' alarms on the 'A' MFP and noticed the pump
controller oscillating. CO placed controller in
Manual and oscillations stopped. Troubleshooting
efforts were initiated.

July 20, 1992 CO received the 'B' MFP 'Shaft Coupling vibration
1613 hours High' alarm. CO noted the 'A' MFP was
running at approximately 10,000 gpm and the 'B' MFP
was running at approximately 20,500 gpm. CO manually
increased the 'A' MFP flow in order to decrease the
'B' MFP flow. This cleared the high vibration alarm.

1634 hours CO was unable to maintain stable feedwater flows. CO
placed the 'B' MFP in Manual.

1759 hours Troubleshooting determined that the 'B' MFP picked up
excessive feedwater flow while in Auto.

2100 hours While in Manual, the 'B' MFP flow had to be increased
slowly over approximately a two-hour period to
prevent flow from shifting over to the 'A' MFP.
Stable Main Feedwater conditions were established.
The 'B' MFP was inspected, but no problems were
noted.

July 21, 1992 Instrumentation and Control (I&C) personnel
1608 hours completed installation of monitoring equipment on MFP
instrument control signals in the Westinghouse- Hagan
Controller racks.

1636 hours Started increasing feedwater flow on the 'B' MFP.

1721 hours Established a 195 psi differential pressure between
the MFPs to allow monitoring of instrument speed
control signals.

July 22, 1992 The 'B' MFP slowed to minimum speed. Attempt was
0125 hours made to increase the 'B' MFP speed manually, but was
unsuccessful. The CO tripped the 'B' MFP, which
initiated a turbine runback.

0126 hours Reactor tripped on low-low steam generator water level. The 'A' AFW Pump Auto-started, then tripped on overspeed. The 'B' AFW Pump Auto-started. The 'A' AFW Pump tripped on overspeed on subsequent attempts to start it.

Event Analysis

The 'A' MFP Failure

The controller module and Manual/Auto Station (Westinghouse-Hagan Controller Model 124) JB, TC! for the 'A' MFP were removed for bench testing. During the first two hours of the test period the controller was placed in automatic and a small step change signal was introduced. The module outputs remained satisfactory during this period. When a second step change was input to the controller, the output integrated off-scale high. The controller output would remain stable when it was placed in Manual. For the next several hours attempts to place the controller in Auto caused the output signal to integrate off-scale high.

The 'B' MFP Failure

Troubleshooting was performed on the 'B' MFP governor controller (Woodward Governor Model 2301, Electronic Control Assembly Model 8270) JB, SC!. Several components on the signal converter JB, CNV!, amplifier JB, AMP!, and voltage switch JB, JS! modules of the Electronic Control Assembly were found to be overheating. Measurements taken during troubleshooting identified several failed components. The component failures were determined to be associated with the power supplied to each module.

During troubleshooting, the Zener Diodes on the amplifier module were found to be hot to the touch. Measurement of the output of the auctioneered power supplies JB, RJX! determined that the lead (primary) power supply was set at 24 VDC and the follower (backup) power supply at 19 VDC. For an auctioneered power supply, the lead power supply is supposed to be set only slightly higher than the follower to forward-bias the diode circuit. The lead power supply was adjusted to 19.3 VDC and approximately 17.7 VDC was measured at the Control Assembly. After this reduction, the Zener diodes were noticeably cooler.

The 'A' AFW Pump Failure

The cause of the overspeed trip of the 'A' AFW Pump was originally diagnosed as a failure of the pump's Electric Overspeed Trip circuitry BA, SC!. However, subsequent testing (manually starting and controlling the pump locally at various speeds) verified that the electric overspeed trip circuitry was functioning normally. Fast starting the pump, however, produced an electric overspeed trip signal. Additional testing was then conducted on the Woodward Governor control circuitry (BA, 65). A start up circuit (Ramp Generator Signal Converter) in the Woodward Governor programs turbine speed to prevent overspeed on turbine startup. It was determined that the Ramp Generator Signal Converter was not generating a ramp or idle speed signal. Without these signals present to control pump startup, the turbine would quickly run up to full speed, overshooting to its overspeed trip setting. The failed Ramp Generator Signal Converter was returned to the vendor for repair and failure analysis.

CAUSE OF OCCURRENCE

The 'A' MFP Westinghouse-Hagan Controller failure was caused by a component failure. The erratic operation of the controller was due to a failed electrical component within the controller module. The particular failed component (or components) has not yet been identified, and is still under investigation.

The 'B' MFP governor electronic control assembly failure was caused by a misadjusted controller power supply. The 24 VDC power supply was set at 24 VDC when it should have been set slightly higher than 19 VDC. Investigation to determine why the supply was set too high identified a Maintenance Request initiated in 1991 to replace a burned out indicating lamp in the lead power supply to the 'B' MFP Governor controller circuit.

While performing the replacement the maintenance personnel discovered that the lead power supply was not functioning properly. The power supply (Lambda Electronics Model LJS-10A-24-OV) BA, RJX! was replaced on April 27, 1991. However, the work instructions directed the personnel to verify that the power supply provided 24 VDC, and did not specify that the supply was to be adjusted to slightly higher than 19 VDC (Output Voltage). The higher voltage and current conditions that the controller circuits were subjected to caused several of the electrical components to overheat and eventually fail. Further investigation as to the reason why the new power supply was not adjusted to the proper voltage revealed that the cause of the improper power supply voltage setting was an inadequate design and review process. Design documents (i.e., drawings, technical manuals, etc.) were not appropriately changed to reflect actual power

supply requirements resulting from a 1982 design change. The 1982 design change replaced the single power supply for the MFP governor electronic control assembly with an auctioneered power supply circuit. Associated design documents were not changed to specify the required voltage settings (of the Lambda Power Supplies) to forward-bias the auctioneered circuit. Thus, when the maintenance request was written to replace the failed Lambda unit in 1991, instructions for adjusting the output of the replacement Lambda unit to the required voltage were not included.

The procedures governing the design process were revised prior to this event but, as noted above, not prior to the actual cause of the occurrence. The new procedures went into effect on April 30, 1992. These new procedures allocate the design process into defined phases and processes for completion, which include required checklists and reviews. In addition, the procedures created a new technical oversight committee entitled the Design Review Board (DRB). One of the functions of the DRB is to review the technical completeness of significant design changes. It is expected that these additional controls on the design review process will prevent this type of failure from recurring.

The 'A' AFW Pump failure was caused by a faulty Ramp Generator Signal Converter in the Woodward Governor control circuitry. This converter had failed on June 1, 1992, and had been replaced on June 3, 1992, with a new converter. The failure of the new converter on July 22, 1992, was determined to be the result of a failed integrated circuit on the printed circuit board. According to the vendor, the failure did not appear to be the result of an external cause, but was probably due to a premature failure of the integrated

circuit due to an internal flaw on the chip.

CORRECTIVE ACTIONS

Actions Completed

1. The failed components on the 'B' MFP governor electronic control assembly were replaced, the power supply was adjusted, the governor was tested satisfactorily, and the 'B' MFP was returned to service.

2. The Westinghouse-Hagan Controller Module for the 'A' MFP was replaced, the control circuitry was tested satisfactorily, and the 'A' MFP was returned to service.

3. The failed 'A' AFW Pump Ramp Generator Signal Converter was replaced

and tested successfully. Power supply voltages were checked when the circuit was replaced and found to be correct.

Actions in Progress

1. Increased frequency testing of the Turbine Driven Auxiliary Feedwater Pump has been implemented. The increased testing frequency will continue for six months as follows: once per week for the first month, twice per month for the next two months, and once per month for the last three months. This testing is intended to monitor for premature component failure by verifying proper operation of the Ramp Generator Signal Converter, and will be done under fast start conditions.

ANALYSIS OF SAFETY CONSEQUENCES AND IMPLICATIONS

There were no safety consequences resulting from the failure of the 'B' MFP or the 'A' AFW Pump. Following the reactor trip, safety systems functioned as required, with the exception of the 'A' AFW Pump. However, the 'B' AFW Pump started and ran normally, and supplied cooling water to the steam generators, as required. Also, it would have been possible to manually start and control locally the 'A' AFW Pump, had it been needed. In addition, the electric-driven auxiliary feedwater pump BA, P! could have been started, if required. Therefore, the subject failures did not prevent the steam generators SB, SG! from receiving an adequate supply of cooling water.

PREVIOUS SIMILAR EVENTS

A reactor trip occurred on June 5, 1992, due to a steam generator high-high water level signal caused by a failed controller for the 'B' Main Feedwater Regulating Valve SJ, FCV!. This event was reported on LER 92-14, dated July 6, 1992. The failure in that event was a manual pushbutton, in which the switch contacts would intermittently stick closed, which caused the 'increase flow' signal to stay in until the steam generator water level reached its high-high setpoint. This was a mechanical failure, not an electronic circuit failure, and was due to a combination of a manufacturing defect and age-relaxation of the switch contacts' spring.

Another reactor trip event, as reported in LER 88-43, dated December 13, 1988, also involved the controller for the 'B' Main Feedwater Regulating Valve. That event was not due to a solid state circuit failure, but a failed capacitor in the controller's power supply. The failed power

supply caused the valve to fail open.

In addition to the above two events, the 'A' AFW Pump Ramp Generator Signal Converter that failed on July 22, 1992, was the replacement for the converter that had failed on June 1, 1992, during testing of the 'A' AFW Pump. The June 1, 1992, failure, which also caused the turbine to trip on startup, was caused by a component failure. The component that failed then was also an integrated circuit, but not the same one that failed on July 22, 1992.

PGE

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(503) 556-3713 October 15, 1992
RDM-516-92

U.S. Nuclear Regulatory Commission
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Gentlemen:

Licensee Event Report No. 92-20, Revision 1, is attached. This report discusses a reactor trip that occurred on July 22, 1992, due to the loss of feedwater flow to the steam generators from the 'B' Main Feedwater Pump. The loss of flow was caused by the failure of several electronic components on the Woodward Governor Electronic Control Assembly. This revised report provides supplemental information concerning the root cause of the controller failure for the 'B' Main Feedwater Pump and the actions taken to prevent recurrence of this type of problem.

Sincerely,

R.D. Machon
General Manager
Trojan Nuclear Plant

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